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The Teaching Mode Starting from the Application Example - Take Linear Algebra Courses as an Example

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Abstract*—*In view of the phenomenon that linear algebra teaching focuses on theory and ignores practical application, and separates concept, definition, principle and practical application, a linear algebra teaching mode based on application examples is proposed. In other words, the teaching mode of linear algebra combines theory with practice to guide students to learn basic knowledge and basic theory from practical problems. In addition, after mastering linear algebra knowledge, students can quickly solve practical problems, so that students can learn with problems, and then apply the knowledge to practical problems, so as to truly stimulate students' desire to learn, and gain the pleasure and self-confidence of solving problems.

Keywords*—*Application examples, teaching models, linear algebra, Mathematical modeling.

I. INTRODUCTION

After penetrating into many branches of mathematics, it has also become one of the theoretical foundations of mathematics supported by artificial intelligence and big data technology [1]. Mainstream intelligent algorithms in unmanned driving, image processing, social networks and communication systems all take linear algebra as their supporting principle, and its importance cannot be denied [2].

Linear algebra is an important basic mathematics course offered by many applied disciplines, which plays a great role in promoting college students' thinking ability, calculation ability, induction and summary ability and analog reasoning ability. As a basic course, how to introduce practical problems into classroom teaching and let students have the ability to apply mathematics knowledge to solve practical problems faster is a problem that teachers have been thinking about in the teaching process.

In the teaching of linear algebra, teachers use various methods such as heuristic teaching, questioning teaching, case teaching and information technology teaching to carry out effective teaching, transform the more abstract and logical content into more specific and easier to understand learning content, help students master the related knowledge of linear algebra, and strengthen their understanding and absorption of the knowledge. Improve the effectiveness of linear algebra teaching [3].

There are many drawbacks in linear algebra teaching, which can be summarized in the following two aspects: First of all, after students enter the university, they fail to break away from the previous exam-oriented education environment. In the actual teaching period, teachers realize that in most cases, students do not have good independent thinking ability, and in learning, they fail to truly grasp the meaning of relevant knowledge points, and often just apply formulas mechanically in the process of solving problems. Lack of deep cognitive understanding, it is not able to carry out flexible use on the basis of understanding. In this case, it is difficult for students to deeply understand the knowledge points, and it is more difficult to apply the knowledge points to solve problems in practice. Secondly, linear algebra is a course that permeates with each other, crisscrossing and has close relationship with the knowledge before and after, and has a very broad application range. At present, most teachers only pay attention to theory and neglect practical application in their teaching. They cannot adapt to taking application as the purpose and the important principle of measuring degree in engineering teaching. At the same time, they seldom combine with other subject knowledge and examples in real life closely.

Therefore, in the actual linear algebra teaching, I put forward the teaching mode based on application examples to effectively improve students' mathematical ability, especially the ability to solve problems. The first is the teaching of basic knowledge, so that the application of examples to penetrate into every mathematical knowledge point; Secondly, by explaining the solution of application examples in real time, students can get the pleasure of applying mathematical knowledge to solve practical problems in class, and then cultivate students' ability to analyze and solve practical problems.

II. THE TEACHING MODE IS BASED ON THE PRACTICAL EXAMPLE

A. Teach concepts by example

The application of teaching cases in linear algebra teaching can, through the creation of case teaching situations, temporarily bring students from boring classroom teaching into scenario-based case discussions, and enable students to cultivate divergent thinking in case discussions, so as to achieve the purpose of effective teaching [4]. In the teaching process of linear algebra, we carry on the teaching of new concepts based on examples. For example, the introduction of matrix multiplication.

First, the teacher introduced the extensive application of matrix multiplication in economics, and then asked the question: After learning matrix, are students used to expressing some regular data lists in the form of matrices? Then it is pointed out that some economic data, whether

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adding data or doubling data, use matrices and their operations. Introduce the concept of matrix multiplication to students by presenting an example in PPT.

The students saw that this quotation was closely related to the actual economic problems, and naturally had the interest in learning. The teacher told the students that the above problems would be solved easily after learning matrix multiplication.

B. Select examples combined with professional background

The teaching requirements and purpose of linear algebra are to gradually cultivate students' abstract thinking ability, logical reasoning ability, spatial imagination ability and self-learning ability through various teaching links while implanting knowledge. Special attention should also be paid to cultivating students' skilled operation ability and comprehensive application of knowledge to analyze and solve problems. In linear algebra teaching for engineering students, it is difficult to produce interactive teaching scenes by simply explaining the ingenuousness of theorems without connecting with reality or enumerating vivid examples.

When teaching this course for different majors, you should give more examples related to their majors. For example, we can explain more examples of production costs and management decisions for students majoring in management, and more examples of information coding and linear algebra applied in programming for students majoring in information engineering. Only in this way can students improve their ability to transform practical problems into mathematical models, expand their learning space, and improve their practical ability and innovative spirit. How to realize the above expectations requires teachers to be good at observation, actively explore and summarize in daily teaching and academic communication, and establish a set of case database showing the application of linear algebra. Only rich teaching materials can properly set up mathematical situations, put forward mathematical problems from different angles, mobilize the enthusiasm of students to learn linear algebra, and improve the active atmosphere in class. For example, when you introduce the concept of a matrix, you first tell the class that the definition of a matrix is a table of numbers, and explain how it is similar to and different from a determinant. In order to further broaden students' horizons and enthusiasm for learning linear algebra, the question "Which problems in life can be represented by matrices?" can be asked. For example, the introduction of grayscale images is a matrix and each element is an integer between 0 and 255; The computer screen is also an example closely related to the matrix, and then introduces the color of the screen is a composite of the three primary colors of red, green and blue, that is, three 1024×768 matrices (commonly used computer screens). These examples can let students experience the ubiquitous matrix in real life, but also broaden the scope of students' knowledge and improve students' interest in learning. After that, I return to the question of why matrices are introduced in mathematics - to represent and solve linear equations. There's also a context question: What's the connection to Cramer's Rule? Cramer's rule is used to discuss the solution of a system of equations. The characteristic of a linear system of equations is that the number of equations and unknowns must be the same, because the determinant used in it is limited. "Can we also use Kramer's law to discuss the solution of a system of unknown and unequal equations?" This problem makes students realize the scope of Cramer's rule, and also lays a good foundation for learning how to apply matrix to solve equations. This provides a bridge between practical application background and mathematical theory, and allows students to understand that matrices are useful and realize that different types of equations have their own principles for solving them.

In today's quality-oriented education, teachers need to connect more extensively with life, other related disciplines or courses, and set up more teaching scenarios. In the teaching process, teachers need to start from practical problems rather than directly from the definition to organize course teaching, first propose some practical problems that can arouse students' interest, and then gradually introduce concepts and methods. Let the students master the knowledge point and know how to use the knowledge point to solve the problem.

C. Application of mathematical modeling to construct examples

The teaching requirements and purpose of linear algebra are to gradually cultivate students' abstract thinking ability, logical reasoning ability, spatial imagination ability and self-learning ability through various teaching links while implanting knowledge. Special attention should also be paid to cultivating students' skilled operation ability and comprehensive application of knowledge to analyze and solve problems. In linear algebra teaching for engineering students, it is difficult to produce interactive teaching scenes by simply explaining the ingenuousness of theorems without connecting with reality or enumerating vivid examples.

Mathematical modeling is the process of establishing mathematical models according to actual problems, then solving the models with mathematical knowledge, and finally solving practical problems according to the calculation results [5]. Based on this, this paper integrates the idea of mathematical modeling into the teaching process of linear algebra, and appropriately introduces typical modeling cases [6,7] to attract students' attention and learning interest, thus activating the classroom teaching atmosphere and improving the teaching effect.

Introducing the idea of mathematical modeling into linear algebra teaching will increase the interest of knowledge, improve students' learning efficiency, and help students grasp the teaching content as soon as possible. For example, in matrix teaching, we can add cryptography problems and predicting the development trend of things, construct models based on examples, and introduce relevant teaching contents. In the teaching of linear equations, we can insert network flow problems and economic equilibrium application examples, construct models, and introduce concepts. The general steps are: problem proposal → model establishment → concept introduction → model solution.

The following is a teaching example of "information

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encryption problem" combined with mathematical modeling.

In the first step, the question is posed: In order to prevent information from being leaked during transmission, encryption is usually required. Now to transmit information is: very good, then how to encrypt the information to transmit it?

The second step, model building: very good can be encoded as 22 5 18 25 2 7 15 15 4, where 2 represents a space and the other letters are represented by their order number in the alphabet. But this encryption can be easily broken, and the information can be further camouflaged with matrix multiplication. First put the above codes into a matrix.Let's call this matrix: $A_1 = \begin{pmatrix} 22 & 5 & 18 \\ 25 & 2 & 7 \\ 15 & 15 & 4 \end{pmatrix}$, the compacting moment matrix is $A_2 = \begin{pmatrix} 2 & 1 & 1 \\ 3 & 2 & 1 \\ -1 & -1 & 1 \end{pmatrix}$, Multiplicative product matrix

$$A_1A_2 = \begin{pmatrix} 22 & 5 & 18 \\ 25 & 2 & 7 \\ 15 & 15 & 4 \end{pmatrix}\begin{pmatrix} 2 & 1 & 1 \\ 3 & 2 & 1 \\ -1 & -1 & 1 \end{pmatrix} = \begin{pmatrix} 41 & 14 & 45 \\ 49 & 22 & 34 \\ 71 & 41 & 34 \end{pmatrix},$$

so the encrypted code is 41, 14, 45, 49, 22, 34, 71, 41, 34.

Multiply a matrix A to the right of A_1A_2, make

$$A_1A_2A = A_1,$$

and this is equivalent to finding a matrix A, make $A_2A = E$, It can be decrypted.

The third step, concept introduction: the definition of inverse matrix.

The forth Step , model solving: In this example, the matrix A to be found is the inverse matrix A_2^{-1} of the square matrix A_2 .And make all the elements in it integers. When constructing the encryption matrix, the identity matrix can be used to carry out several third class elementary transformations, so that $|A_2| = 1$.

When introducing mathematical modeling cases, we should pay attention to the following aspects [8,9]: First, in the process of introducing cases, we should give students appropriate time and space, assign some thinking questions, and let students volatilize freely, which may receive better results. Second, the more simple the choice of cases, the more close to life, the more conducive to understanding the better. On the one hand, if students can choose the cases around them, they can often feel more appropriate and more real, which may have a surprising effect. On the other hand, if students can be involved in the selection of cases, it can activate the classroom atmosphere, increase students' interest and enthusiasm, and cultivate students' divergent thinking peacekeeping is linked to practical awareness. Third, new cases and old cases should be well combined, it is good to create new cases in the teaching process, so as to increase the freshness of the course. If there are no new cases, making full use of old cases can also achieve the ideal effect. In addition, although mathematical modeling case teaching can improve the quality of teaching, elaborate lesson preparation and teaching are still necessary. How to choose cases, how to organize language, how to explain cases, and how to maximize the teaching effect should be the goal pursued by every teacher.

III. The Effectiveness of Teaching Mode Based on Application Examples

After adopting the teaching mode based on application examples in the classroom teaching of my four classes, the classroom teaching atmosphere is getting better and better, and the classroom interaction between teachers and students is increasing. Students generally reported that they were no longer disgusted with boring math classes and no longer afraid of abstract math knowledge. Students' interest in mathematics learning has been widely improved, and students who failed advanced mathematics in their freshman year are also willing to actively study linear algebra courses, and no longer skip classes or play mobile phones during class sleep.

Some excellent students have the habit of following the teacher's board to write class notes, organize class notes neatly, and do math homework correctly and standardized. Taking advantage of the situation, the teacher initiated the activity of taking class notes in the whole class, encouraging students to first take pictures of the blackboard written by the teacher in class with their mobile phones, and then organize class notes after class. This made students have the consciousness of learning mathematics, and generally improved the passing rate of the final exam of linear algebra.

IV. Conclusion

In short, teachers explain definitions, properties, theorems and other knowledge points from application examples in the teaching of linear algebra. At the same time, they take the way of abstraction, contrast and setting the background of problems, which gradually makes students feel the interest of linear algebra and generate a strong desire for knowledge. Teachers should constantly broaden the scope of knowledge, strengthen communication, deepen accumulation, and explore feasible and efficient classroom teaching methods combining theory with practice. At present, the mathematical Contest in Modeling is in full swing. The linear algebra teaching reform introducing mathematical modeling cases plays a positive role in promoting the training of current application-oriented talents, and effectively enhances students' ability to solve practical problems by using mathematical knowledge [10].

In the face of the new situation that higher education is developing in depth and the society is in urgent need of high-quality applied talents, the teaching reform of linear algebra course is not to pursue the speed and intensity of reform, but to combine the actual learning ability of students, so that students can master mathematical knowledge and mathematical ability in a relaxed and pleasant environment, and then have the ability to solve practical problems.

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